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Feed Grain Trade and Transportation Policy Impacts Upon the Cornbelt Economy: A Multi-Industry Approach

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Introduction

Changes in export policy and transportation rates influence the market structure of the feed grain industry, alter the demand for transportation services and modify the volume and directional flow of feed grains through the marketing channels.[1] These changes also directly and indirectly affect the economic activities of rural communities. For example, the grain industry employs individuals from the labor force, buys inputs from other sectors, and sells products and services valued at billions of dollars. The purpose of this paper is to examine the effects of changes in feed grain exports and transportation rates on employment levels, income levels, aggregated output and the economic activity of selected industries in the Cornbelt.[2]

Agricultural, fiscal, and monetary policies of the 1980s caused U.S. feed grain exports to decline from a high of 2.7 billion bushels in 1980 to a low of 1.5 billion bushels in 1985, a 44 percent decrease (Figure 1). Expressed in dollar values, feed grain exports also reached their peak in 1980 at $9.8 billion, declining to a low of $3.0 billion in 1986. This represents a 37 percent decrease between 1980 and 1985, or a 69 percent decrease for the 1980 - 1986 period. The significant decline in the dollar value of exports between 1985 and 1986 is the result of lower feed grain prices and the continued competition from foreign suppliers.

Research from the 1970s documented that the Cornbelt transported large quantities of feed grains to export points including the Great Lakes, Atlantic, and the Gulf ports [Leath, Hill and Fuller]. The 1985 corn flow data also illustrate the importance of exports to the Cornbelt

economy. To date, other researchers have analyzed the aggregated effects of the decline in exports on the national economy [Harrington et al., and Rausser et al.] However, researchers have not analyzed the specific effects of these changes on selected economic indicators for a specific agricultural region, such as the Cornbelt. The important economic question, therefore, is: "Do changes in the dollar value of feed grain exports have significant effects on employment, income levels and output in related industries in the Cornbelt, and if so, what related industries are most affected?"

Changes in transportation rates may also affect trade patterns between the Cornbelt and its trading partners, and subsequently the economic well-being of rural communities. The Staggers Rail Act and Motor Carrier Act of 1980 granted railroads and trucking companies, respectively, the right to negotiate rates instead of adhering to posted regulated rate schedules. Although truck rates had been competitively negotiated for some time, there was concern regarding the impact of potential rail rate increases. These policy changes and other factors, such as fuel costs, increased truck rates 5 percent in the 1980s while rail rates increased 57 percent [USDA, Office of transportation].

Prior research analyzed the effects of rail rate changes, rail abandonment, and railroad consolidations on the structure and flow of grain for the national grain system and for some selected state grain systems [Baldwin and Larson; Baumel; Chow, Babock and Sorenson; Hoffman, Hill, and Leath]. Studies such as these employed a linear programming framework or used a case study approach to analyze the immediate impact of a change in rail rates on a narrowly defined grain sector. Rarely were

the secondary effects or induced impacts (i.e., the linkages to other industries) analyzed. The only studies that did examine the linkages between the grain sector and other industries used national or state input-output models [Harrington, Schulter, and O'Brian]. Linkages for a specific region with an important grain sector, such as the Cornbelt, were not previously analyzed. Changes in costs were not simulated due to constant-cost input-output coefficients.

Methodology and Data

To analyze the impact of a decrease in exports and an increase in transportation costs on the Cornbelt economy, a one region input-output (I/O) endogenously determined household sector model is used to derive the macro data. The conceptual idea behind the I/O analysis is that industrial sectors in the Cornbelt are interrelated [Richardson]. The feed grain sector's output, for example, is used as an input by the dairy, livestock, and manufacturing sectors, and feed grains are shipped to export points and to deficit feed grain regions. The feed grain sector also buys goods and services from the manufacturing, transportation, finance and banking, construction, and household sectors. The I/O model is analogous to a double-entry accounting system whereby the sum of the inputs from all sectors equals total outputs from all sectors. The total dollar output from one sector is consumed as dollar inputs by all other sectors.

For this analysis, the Cornbelt region I/O model is comprised of 13 sectors: dairy; livestock; feed grain; other agriculture; mining; construction; food manufacturing; non-food manufacturing; transportation; wholesale and retail trade; finance and banking; other services; and households.[3] These 13 sectors, representative of the Cornbelt economy,

buy outputs from and/or sell inputs to the feed grain sector. All data were derived from the 1977 Survey of Current Business, the most recent publication of national I/O data [Bureau of Economic Analysis]. A micro computer program, ADOTMATR, was used to create regional Cornbelt data from national data [Lamphear and Konecny]. The standard locational quotient regionalizing procedure transformed the national technical coefficients into Cornbelt technical coefficients.

Direct Requirement Table

The direct requirement table for the Cornbelt shows the proportion of a sector's inputs that are required from each of the other sectors, as well as from itself. Based on the 1977 I/O data, 22.7 percent of all feed grain sector expenditures are used to purchase inputs from the non-food manufacturing sector (Table 1, Feed Grain Column). Since the feed grain production and marketing system is capital-intensive, the feed grain sector uses a proportionally large share of inputs from the non-food manufacturing sector.

The feed grain sector is also directly linked to the finance and banking sector, wholesale and retail trade, feed grain sector itself, households, and the transportation sector. Both the feed grain production and merchandizing functions are financed by commercial lenders. Wholesalers and retailers are involved in the production and marketing of feed grains and their products. To avoid ....., the I/O format measures only the gross margins for the wholesale and retail sector. The feed grain sector purchases grain and services from itself, labor from the household sector, and services from the transportation sector. Increasing

the production and marketing of feed grains stimulates additional production and output in these and other sectors in the Cornbelt (Table 1).

The last row in the direct requirements table is the value added row, which represents the returns to investment and acquisition of inputs from non-Cornbelt regions. The value added row shows that the feed grain sector not only purchased outputs of other Cornbelt sectors, but also outputs from other non-Cornbelt regions in the U.S. and imports from other countries. In other words, to produce and market feed grains, the Cornbelt feed grain sector acquired large quantities of petroleum products, fertilizers, chemicals, and transportation services from outside the Cornbelt region. Based on the 1977 data, over 50 percent of all feed grain sector inputs were from non-Cornbelt industries or represented returns to investment (Table 1).

The direct requirement table also shows the proportion of the feed grain sector's outputs that are used as inputs by other industries in the Cornbelt. About 34 percent and 24 percent of all dairy sector inputs and other livestock inputs, respectively, are acquired from the feed grain sector (Table 1, Feed Grain Row). Much smaller proportions are used as inputs by the feed grain sector itself, food manufacturing sector, other agriculture, and non-food manufacturing sector.

Final Demands

To complete the I/O model, final demands (net sales by sector to non-Cornbelt industries) are derived from the regionalized I/O data. These estimates are found by subtracting the Cornbelt demand (intermediate demand) from total output obtained from Census data [Miller and Blair]. The manufacturing sector sold $80.7 billion dollars to non-Cornbelt indus-

tries both in the U.S. and abroad (Table 2). The feed grain sector sold $6.1 billion dollars to non-Cornbelt industries, approximately 1.5 percent of the total $230.1 billion of final demand. The zero entries (0) for a Cornbelt sector, such as dairy, indicate that estimated intermediate demands for the dairy sector were greater than total output, or that the dairy sector in the Cornbelt was a net importer.

Linear Programming

A linear programming methodology was used to generate an optimal solution, incorporate resource constraints and analyze the micro implications for the feed grain sector. Following the methods of Penn and Irwin, the direct requirements (technical) coefficients for the I/O model were converted into linear programming input coefficients, which represent the intermediate demands (Table 3). These intermediate demands were subtracted from endogenously determined total output such that final demands, the residuals, or exogenously determined "right hand sides" were met. Final demands derived in the I/O formulation were used as final demands or right hand sides in the LP model. The model solves for the sum of intermediate and final demands by maximizing total Cornbelt gross product or revenue. Although not reported in this paper, labor resource constraints can be included in the model and grain flow patterns can be analyzed.

Results

Results are reported for three scenarios: the base model; a decrease in exports; and an increase in transportation costs. Coefficients in the base model are reported in Table 3 and represent 1977 I/O data. Like all I/O formulations, the results are valid for the current period assuming that the 1988 relative price levels among the sectors are the same as the

ones implied in the 1977 data. For the second scenario, exports from the Cornbelt are decreased by 25 percent, which approaches the decrease in the value of exports for the 1977 - 1987 time frame. The input coefficients in the linear programming model are the same as for the base model. However, the final demand for feed grains in the "right hand side" or constraint column is reduced to $4.6 billion (Table 4).

For the third scenario, truck and rail transportation rates are increased by 12 percent, a weighted average increase for both modes of transportation for the period 1977 - 1987 period. The model captures only shipments made within the Cornbelt. Therefore, barge rates were irrelevant since no significant amount of corn was moved by barge within the Cornbelt. All final demands, as entered in the "right hand side" column, are unchanged relative to the base model. Using procedures developed by Liew and Liew, the technical coefficients for the feed grain sector in the I/O model were modified. Thus, the feed grain sector's input coefficients in the linear programming model were changed relative to that for the base model (Table 5).

Base Model

The total gross regional output for the base model is $798.7 billion, final demand equals $230.1 billion and intermediate demand equals $568.6 billion (Table 6). Households generate $261.9 billion dollars. The non-food manufacturing sector generates $253.2 billion, services $64.2 billion, food manufacturing $44 billion, finance $42.7 billion and transportation $30 billion. The feed grain sector is most important of the four agricultural sectors producing $11 billion, which is 1.4 percent of the gross regional output.

The quantity of output from the feed grain sector should not be compared to the level of output produced by other sectors, such as manufacturing. The chosen disaggregation process separated the feed grain sector from the total agricultural sector, while the manufacturing sector was not subdivided into separate industries. Therefore, such a comparison would be biased as the output of the one-feed grain industry would be compared to the output of many industries that make up the manufacturing sector. The unrealistic result would be that the feed grain sector is relatively unimportant economically to the Cornbelt.

The shadow prices or output multipliers vary from a low of $1.9 for the finance and banking sector to a high of $3.8 for the construction sector. Every additional dollar generated by the feed grain sector increases total output in the Cornbelt by $2.60. This relatively small multiplier for feed grains reflects this sector's capital-intensive, specialized, and productive nature. In the Cornbelt, feed grain production has increased many fold. Specialized production techniques create a demand for specialized inputs, such as chemical fertilizers, that the feed grain sector purchases from non-Cornbelt regions. A significant share of feed grain revenues leave the Cornbelt economy to make such purchases. Contrast this finding to the relatively large multiplier for the livestock sector, an industry which has not increased its productivity in either the production, marketing, or processing sectors.

The labor multipliers vary from a low of 1.4 jobs for the wholesale and retail trade sector to a high of 8.3 jobs for the food manufacturing sector. The labor multiplier for the feed grain sector is 2.4 jobs, about in the middle of the other 12 industrial sectors. A one dollar increase

in output in the feed grain sector increases direct feed grain employment by .000052 jobs ($1.0 of additional output * 2.41 labor multiplier * .0000214 jobs per dollar of output).

The income multipliers vary from a low of $1.90 for the wholesale and retail trade sector to a high of $10.2 for the feed grain sector. The relatively large income multiplier for the feed grain sector again reflects its capital intensive nature. As output increases in this sector, very little expenditure is made purchasing labor from the household sector. The total income effect for the Cornbelt is relatively small because of this small linkage (the technical coefficient is 0.036) between the feed grain sector and the household sector. A one dollar increase in output for the feed grain sector only generates a total income effect equalling $0.369 ($1.0 additional output * 10.25 income multiplier * 0.036 technical coefficient).

Decrease Exports Model

Decreasing exports by 25 percent causes gross regional output in the Cornbelt to decline by $3.9 billion dollars, final demands by $1.5 billion, while annual intermediate demand decreases by $3 million (Table 6). The decrease in gross regional output and final demand was less than one-half of one percent. Further, the agricultural policy of the 1980s offset some of the lost revenue as the federal government subsidized agricultural production of both feed grains and on- and off-farm storage activities.

The feed grain sector sustains the largest annual loss equaling $1.6 billion, nearly a 15 percent decrease in total output. This decrease explains in part the farm financial crisis of the 1980s and the observed

closing and consolidation of grain elevator plants and firms in the Cornbelt. During this period, farmers continued to produce relatively large quantities of feed grains. Quantities of grain stored on farms and at elevators soared, and smaller quantities of feed grains were shipped to export points via rail and barge facilities [USDA Agricultural Statistics and Baldwin and Larson].

Non-food manufacturers lost $830 million from decreased exports, households $561 million, the finance and banking sector $227 million, wholesale and retail trade $130 million and the transportation sector $126 million. For all sectors, this is less than a one percentage point loss in total gross output. If the industrial sectors were further disaggregated, the percentage loss for specialized sectors such as farm machinery manufactures and dealers, would have been significantly higher.

These findings explain in part the financial crisis that occurred in agricultural input industries of the Cornbelt. Because of lost sales to the feed grain sector, bankruptcies and consolidations occurred in industries that were highly dependent on the feed grain sector. Machinery manufacturers, wholesale and retail dealerships, and many rural banks were in serious financial trouble. Railroad cars were in excess supply and barges were used to store grain on the interior river systems.

Based on the results from the model, the 25% decrease in feed grain export value expressed as a $1.5 billion decrease over the ten-year period would have caused the loss of 77,000 jobs across the entire Cornbelt. Of this total, 34,000 jobs were lost in the feed grain sector. Undoubtedly, other factors prevented such a drastic loss of jobs; however, this

pressure to decrease employment explains, in part, the relatively high unemployment rate for the Cornbelt.

Total income in the Cornbelt due to the decline in feed grain exports decreased by $550 million. Household income losses in the feed sector alone equaled $57 million.

Increased Transportation Rate Model

Increasing transportation rates in this one-region model reduce Cornbelt gross regional output by $1.5 billion, less than one half of one percent. Since final demand did not decrease, intermediate demand decreased by the full amount, $1.5 billion (Table 6). The increase in the transportation rates decreases the feed grain sector's output by $621 million, a 5.6 percent decrease relative to the base model. The output for the manufacturing, households, services, wholesale/retail trade and transportation sectors is also reduced by less than one half of one percent relative to the base model (Table 6). Smaller quantities of feed grains are shipped within the Cornbelt, while some intermediate demand is supplied by importing grain from non-Cornbelt regions.

These results are realistic only if rate increases did not simultaneously occur in non-Cornbelt regions. These results as reported in this paper could be interpreted as a relative transportation rate increase in the Cornbelt economy vis-a-vis the rest of the U.S. The rate increase could occur if roads and rail facilities were allowed to deteriorate in the Cornbelt and/or if other regions of the U.S. subsidized their transportation system.

This restrictive assumption limits the usefulness of these findings and suggests that at least a two-region model, which disaggregates the

transportation sector into grain shipments by modes of transportation and type of industry across regions, is required to effectively analyze transportation rate increases.

Conclusions and Implications

A one-region-13-sector I/O model was created to analyze the effects of a decrease in feed grain exports and an increase in transportation rates on the Cornbelt economy. To overcome the methodological limitations of the I/O model, the technical I/O coefficients were converted into linear programming input coefficients. The linear programming model maximized gross regional output for the Cornbelt.

The one-region model was useful for analyzing the economic effects of a decrease in exports on the feed grain sector and the Cornbelt economy. The feed grain sector contributes approximately $11 billion dollars of total output to the Cornbelt, or less than two percent of total gross regional output.

The output and employment multipliers for the feed grain sector are relatively small when compared to multipliers for the other industrial sectors. In contrast, the income multiplier for the feed grain sector is relatively large. However, the potential increase in total income from an increase in output in the feed grain sector is relatively small because of the weak link to the household sector. These findings are not surprising since the feed grain sector is highly efficient and capital intensive. Large quantities of output are produced with a limited quantity of inputs. These findings imply that an increase in output in the feed grain sector will not have as large an effect on aggregate output, employment or income as will a comparable increase in another industry.

The observed decrease in feed grain exports of the 1980s did not have a major impact on the total Cornbelt economy, reducing gross regional output by less than one-half of one percent. However, output from the feed grain sector was reduced by 15% or by $1.6 billion. Output for a specific industry, such as farm machinery manufactures or dealerships, would also be reduced significantly. Such a loss in exports translated into a loss of 77,000 jobs in the Cornbelt economy. These findings explain in part why the feed grain sector and its input suppliers experienced a recession during the first half of 1980s while the general economy was enjoying overall economic growth.

Rural policy makers, farmers and agribusiness people should recognize that the overall economic health of the feed grain sector is currently linked to the export market. Although rural policy makers, farmers, and agribusiness people probably cannot persuade national policy makers to develop national or international economic policies that will directly benefit the feed grain sector at the expense of the health of other sectors, specific micro economic policies that impact on the level of exports should be targeted and supported.

The one-region linear programming model was not particularly useful for analyzing an increase in transportation rates for the Cornbelt. Procedurally, it was not feasible to disaggregate transportation rates across regions, transportation modes and industries. Thus, feed grains were imported into the Cornbelt to meet intermediate demands, an unrealistic finding. Further, the decrease in output for each sector may have been overstated.

Creating a two region linear programming model will eliminate part of the procedural problem. Thus, a model is currently being designed and solved. The second part of the problem, disaggregating the data across transportation modes and industries, cannot be easily remedied. It is not feasible to disaggregate the I/O data into shipments by mode of transportation and type of industry. One alternative is to use the 1977 and 1985 grain flow data collected by the respective regional committees in conjunction with the I/O data for this purpose.

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Footnotes

1. Feed grains include corn, sorghum and oats.

2. The Cornbelt includes Ohio, Indiana, Illinois, Iowa and Missouri.

3. The feed grain sector is comprised of production enterprises earning at least 50 percent of their total revenue from the sale of corn, sorghum, or oats.

FIGURE 1: **Exports of Feed Grains, 1979–86**

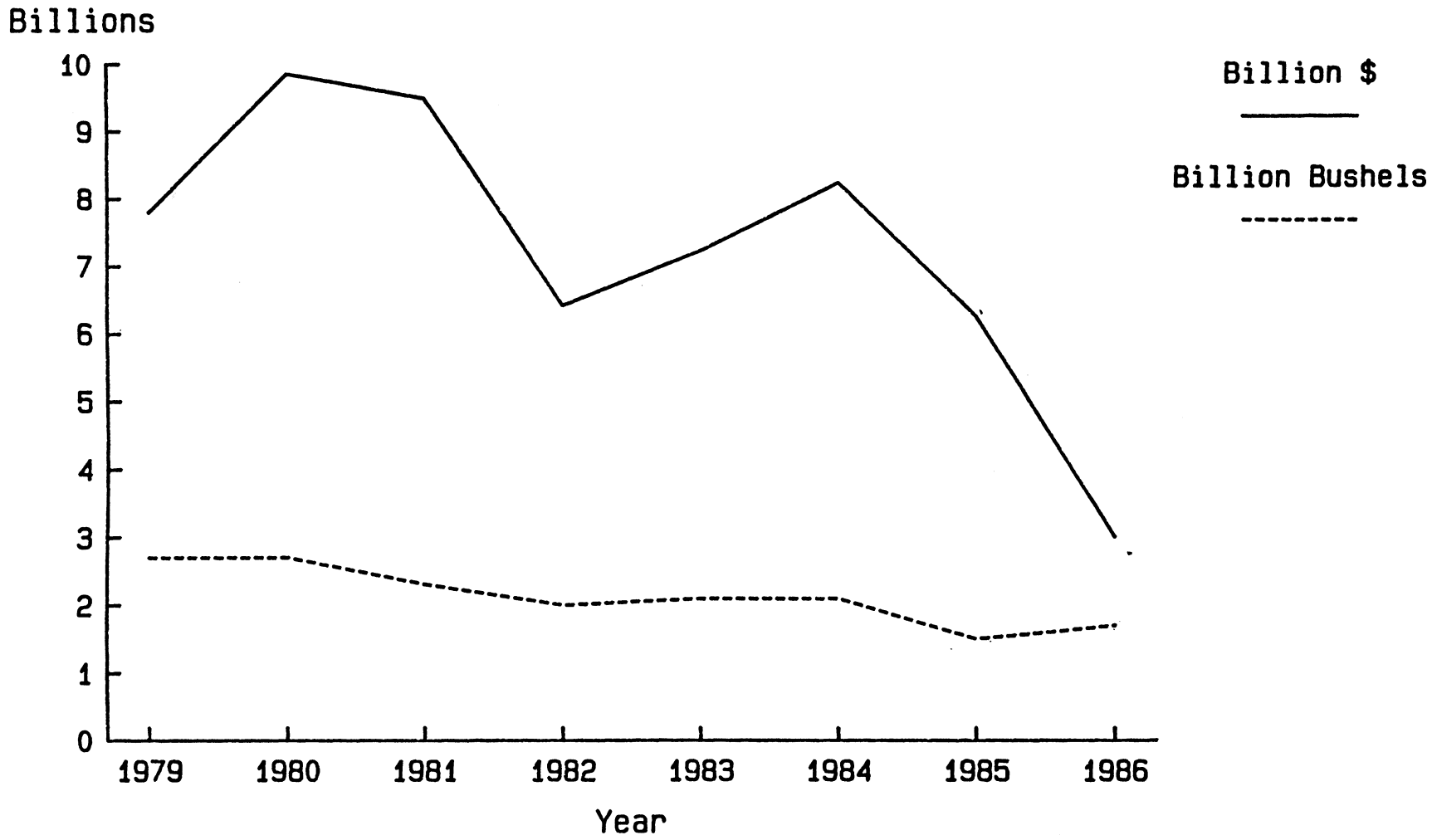

Table 1: Direct Requirements for the Cornbelt Base Model: 13 Sectors, Technical Coefficients[1] and Value Added

	Dairy	Live-stock	Feed Grain	Other Agr.	Min-ing	Con-struc-tion	Mftg. Food	Mftg.	Trans-porta-tion	Whole/ Retail Trade	Finance Bank-ing	Ser-vice & others	House-hold
	PERCENTAGES												
Dairy	0.13	0.31	0.48	0.03	0	0	2.45	0	0	0	0	0.03	0.06
Livestock	0.11	22.07	2.41	1.12	0	0	14.30	0.02	0	0	0	0.13	0.24
Feed Grain	34.18	23.86	3.79	0.07	0	0	3.05	0.01	0	0	0	0.18	0.05
Other Agr.	0.71	1.25	0.94	2.34	0	0.07	1.83	0.20	0	0.05	0.11	0.10	0.21
Mining	0.01	0.01	0.12	0.03	1.79	0.23	0.03	1.41	1.68	0.01	0	0.07	0.04
Construction	0.68	0.49	1.01	1.29	3.23	0.10	0.40	0.49	3.03	0.57	4.31	1.81	0
Mftg.-Food	21.03	21.01	0.01	0.26	0.01	0.02	17.18	0.17	0.03	0.09	0	5.15	8.91
Mftg.	2.95	3.64	22.68	13.03	9.43	37.39	11.63	33.74	9.63	4.12	1.35	9.36	20.34
Transportation	2.39	1.67	2.69	1.82	2.16	1.97	2.41	2.62	9.87	3.46	1.25	3.45	5.33
Whole/Retail Tr.	1.65	2.33	2.94	2.16	0.85	4.82	2.96	1.88	0.74	0.71	0.15	1.54	9.74
Finance, Banking	2.46	2.34	7.38	4.26	4.53	0.70	0.45	0.67	1.30	3.32	8.12	2.94	12.31
Service & Other	0.84	1.26	1.74	1.91	2.34	4.31	3.84	2.83	4.56	8.02	3.46	6.45	16.58
Household	5.66	5.59	3.60	14.52	15.26	31.82	12.48	33.77	26.26	39.22	13.64	39.28	0
Value Added	26.50	14.17	50.21	58.16	60.40	18.57	27.03	22.17	42.90	40.43	67.61	29.51	26.19

[1] The technical coefficients have been multiplied by 100 for ease of presentation.

Table 2: Industry Final Demands, Cornbelt, 1977, Base Model

Sector	Final Demand ($ 000)
1. Dairy Farm Products	0
2. Livestock	763,380
3. Feed Grain	6,085,210
4. Other Agriculture	0
5. Mining	0
6. Construction	31,727,280
7. Manufacturing-Food	6,798,380
8. Manufacturing	80,742,240
9. Transportation	0
10. Whole/Retail Trade	0
11. Finance, Banking	0
12. Service and Other	0
13. Household	103,954,400
TOTAL	230,070,880

Table 3: Model Specifications for the 1977 Cornbelt Economy: Base Linear Programming Model[1]

	Dairy	Live-stock	Feed Grain	Other Agr.	Min-ing	Con-struc-tion	Mftg. Food	Mftg.	Trans-porta-tion	Whole/ Retail Trade	Finance Bank-ing	Ser-vice & others	House-hold	RHS[2]
	DOLLARS													(000 $)
Dairy	0.9987	-0.0031	-0.0048	-0.0003	0	0	-0.0245	0	0	0	0	-0.0003	-0.0006	
Livestock	-0.0011	0.7793	-0.0241	-0.0112	0	0	-0.1430	-0.0002	0	0	0	-0.0013	-0.0024	763,380
Feed Grain	-0.3418	-0.2386	0.9621	-0.0007	0	0	-0.0305	-0.0001	0	0	0	-0.0018	-0.0005	6,085,210
Other Agr.	-0.0071	-0.0125	-0.0094	0.9766	0	0	-0.0183	-0.0019	0	-0.0005	-0.0011	-0.0010	-0.0021	
Mining	-0.0001	-0.0002	-0.0012	-0.0003	0.9821	-0.0023	-0.0003	-0.0142	-0.0168	-0.0001	0	-0.0007	-0.0004	
Construction	-0.0068	-0.0049	-0.0102	-0.0129	-0.0323	0.9990	-0.0039	-0.0049	-0.0303	-0.0058	-0.0431	-0.0181		31,727,280
Mftg.-Food	-0.2103	-0.2101	-0.0001	-0.0026	-0.0001	-0.0002	0.8282	-0.0017	-0.0003	-0.0009	-0.0000	-0.0515	-0.0891	6,798,380
Mftg.	-0.0295	-0.0364	-0.2268	-0.1303	-0.0943	-0.3739	-0.1163	0.6626	-0.0963	-0.0412	-0.0135	-0.0936	-0.2034	80,742,240
Transportation	-0.0239	-0.0167	-0.0269	-0.0162	-0.0215	-0.0197	-0.0241	-0.0262	0.9013	-0.0346	-0.0125	-0.0344	-0.0533	
Whole/Retail Tr.	-0.0165	-0.0233	-0.0294	-0.0216	-0.0085	-0.0482	-0.0296	-0.0188	-0.0074	0.9929	-0.0015	-0.0154	-0.0974	
Finance, Banking	-0.0246	-0.0233	-0.0738	-0.0426	-0.0453	-0.0069	-0.0045	-0.0066	-0.0130	-0.0332	0.9188	-0.0294	-0.1231	
Service & Other	-0.0084	-0.0126	-0.0174	-0.0191	-0.0234	-0.0431	-0.0384	-0.0283	-0.0456	-0.0802	-0.0346	0.9355	-0.1658	
Household	-0.0566	-0.0559	-0.0360	-0.1452	-0.1526	-0.3182	-0.1248	-0.3377	-0.2626	-0.3922	-0.1364	-0.3928	1.0000	103,954,400

[1] The input coefficients for the linear programming model are [I-A] where I is the identity matrix and A is the direct requirements, Table 1.

[2] All rows are less than or equal to constraints.

Table 4: Model Specifications for the Cornbelt Economy: A Decrease in Exports, Linear Programming Model[1]

	Dairy	Live-stock	Feed Grain	Other Agr.	Min-ing	Con-struc-tion	Mftg. Food	Mftg.	Trans-porta-tion	Whole/ Retail Trade	Finance Bank-ing	Ser-vice & others	House-hold	RHS[2]
	DOLLARS													(000 $)
Dairy	0.9987	-0.0031	-0.0048	-0.0003	0	0	-0.0245	0	0	0	0	-0.0003	-0.0006	
Livestock	-0.0011	0.7793	-0.0241	-0.0112	0	0	-0.1430	-0.0002	0	0	0	-0.0013	-0.0024	763,380
Feed Grain	-0.3418	-0.2386	0.9621	-0.0007	0	0	-0.0305	-0.0001	0	0	0	-0.0018	-0.0005	4,563,910
Other Agr.	-0.0071	-0.0125	-0.0094	0.9766	0	-0.0008	-0.0183	-0.0019	0	-0.0005	-0.0011	-0.0010	-0.0021	
Mining	-0.0001	-0.0002	-0.0012	-0.0003	0.9821	-0.0023	-0.0003	-0.0142	-0.0168	-0.0001	0	-0.0007	-0.0004	
Construction	-0.0068	-0.0049	-0.0102	-0.0129	-0.0323	0.9990	-0.0039	-0.0049	-0.0303	-0.0058	-0.0431	-0.0181	0	31,727,280
Mftg.-Food	-0.2103	-0.2101	-0.0001	-0.0026	-0.0001	-0.0002	0.8282	-0.0017	-0.0003	-0.0009	-0.0000	-0.0515	-0.0891	6,798,380
Mftg.	-0.0295	-0.0364	-0.2268	-0.1303	-0.0943	-0.3739	-0.1163	0.6626	-0.0963	-0.0412	-0.0135	-0.0936	-0.2034	80,742,240
Transportation	-0.0239	-0.0167	-0.0269	-0.0162	-0.0215	-0.0197	-0.0241	-0.0262	0.9013	-0.0346	-0.0125	-0.0344	-0.0533	
Whole/Retail Tr.	-0.0165	-0.0233	-0.0294	-0.0216	-0.0085	-0.0482	-0.0296	-0.0188	-0.0074	0.9929	-0.0015	-0.0154	-0.0974	
Finance, Banking	-0.0246	-0.0233	-0.0738	-0.0426	-0.0453	-0.0069	-0.0045	-0.0066	-0.0130	-0.0332	0.9188	-0.0294	-0.1231	
Service & Other	-0.0084	-0.0126	-0.0174	-0.0191	-0.0234	-0.0431	-0.0384	-0.0283	-0.0456	-0.0802	-0.0346	0.9355	-0.1658	
Household	-0.0566	-0.0559	-0.0360	-0.1452	-0.1526	-0.3182	-0.1248	-0.3377	-0.2626	-0.3922	-0.1364	-0.3928	1.0000	103,954,400

[1] The input coefficients for the linear programming model are [I-A] where I is the identity matrix and A is direct requirements for the decrease in exports I/O model.

[2] All rows are less than or equal to constraints.

Table 5: Model Specifications for the Cornbelt Economy: An Increase in Transportation Rates, Linear Programming Model[1]

	Dairy	Live-stock	Feed Grain	Other Agr.	Min-ing	Con-struc-tion	Mftg. Food	Mftg.	Trans-porta-tion	Whole/ Retail Trade	Finance Bank-ing	Ser-vice & others	House-hold	RHS[2]
	DOLLARS													(000 $)
Dairy	0.9987	-0.0031	-0.0048	-0.0003	0	0	-0.0245	0	0	0	0	-0.0003	-0.0006	
Livestock	-0.0011	0.7793	-0.0241	-0.0112	0	0	-0.1430	-0.0002	0	0	0	-0.0013	-0.0024	763,380
Feed Grain	-0.2088	-0.2097	0.9667	-0.0006	0	0	-0.0268	-0.0001	0	0	0	-0.0016	-0.0004	6,085,210
Other Agr.	-0.0071	-0.0125	-0.0094	0.9766	0	-0.0008	-0.0183	-0.0019	0	-0.0005	-0.0011	-0.0010	-0.0021	
Mining	-0.0001	-0.0002	-0.0012	-0.0003	0.9821	-0.0023	-0.0003	-0.0142	-0.0168	-0.0001	0	-0.0007	-0.0004	
Construction	-0.0068	-0.0049	-0.0102	-0.0129	-0.0323	0.9990	-0.0039	-0.0049	-0.0303	-0.0058	-0.0431	-0.0181	0	31,727,280
Mftg.-Food	-0.2103	-0.2101	-0.0001	-0.0026	-0.0001	-0.0002	0.8282	-0.0017	-0.0003	-0.0009	0	-0.0515	-0.0891	6,798,380
Mftg.	-0.0295	-0.0364	-0.2268	-0.1303	-0.0943	-0.3739	-0.1163	0.6626	-0.0963	-0.0412	-0.0135	-0.0936	-0.2034	80,742,240
Transportation	-0.0239	-0.0167	-0.0269	-0.0162	-0.0215	-0.0197	-0.0241	-0.0262	0.9013	-0.0346	-0.0125	-0.0344	-0.0533	
Whole/Retail Tr.	-0.0165	-0.0233	-0.0294	-0.0216	-0.0085	-0.0482	-0.0296	-0.0188	-0.0074	0.9929	-0.0015	-0.0154	-0.0974	
Finance, Banking	-0.0246	-0.0233	-0.0738	-0.0426	-0.0453	-0.0069	-0.0045	-0.0066	-0.0130	-0.0332	0.9188	-0.0294	-0.1231	
Service & Other	-0.0084	-0.0126	-0.0174	-0.0191	-0.0234	-0.0431	-0.0384	-0.0283	-0.0456	-0.0802	-0.0346	0.9355	-0.1658	
Household	-0.0566	-0.0559	-0.0360	-0.1452	-0.1526	-0.3182	-0.1248	-0.3377	-0.2626	-0.3922	-0.1364	-0.3928	1.0000	103,954,400

[1] The input coefficients for the linear programming model are [I-A] where I is the identity matrix and A is direct requirements for an increase in transportation rates I/O model.

[2] All rows are less than or equal to constraints.

Table 6: Total Sectoral Output for Base Model and Relative Decrease in Output for a 25% Decrease in Feed Grain Exports and a 12% Increase in Transportation Rates

	BASE MODEL				SIMULATIONS	
Sectors	Activities	Shadow Prices or Multi-pliers	Labor Multi-pliers	Income Multi-pliers	Decrease Exports	Increase Transporta-tion Costs
	(000 $)	($)	(Jobs)	($)	(000,000 $) Change From Base - - Activities - -	
Dairy	1,346,105	3.15	3.29	7.18	- 11	- 4
Livestock	10,392,812	3.75	3.24	8.66	- 70	- 27
Feed Grain	11,039,683	2.58	2.41	10.25	-1,605	-621
Other Agr.	2,303,654	2.37	1.72	2.87	- 22	- 8
Mining	4,440,835	2.26	2.39	2.63	- 17	- 6
Construction	37,649,000	3.78	4.01	2.81	- 40	- 15
Mftg.-Food	43,958,206	3.47	8.30	4.46	- 95	- 37
Mftg.	253,208,499	3.64	4.29	2.57	- 830	-321
Transportation	29,964,866	2.85	2.53	2.37	- 126	- 49
Whole/Retail Tr.	35,584,224	2.92	1.43	1.88	- 130	- 50
Finance, Banking	42,711,716	1.98	2.09	2.34	- 227	- 88
Service & Other	64,218,933	3.31	1.76	2.08	- 188	- 73
Household	261,872,689	3.30	48.48	3.30	- 561	-217
GRO -	798,691,223				-3,921	-1,517
FD -	230,070,880				-1,521	

GRO - Gross Regional Output

FD - Final Demand